



# UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE  
United States Patent and Trademark Office  
Address: COMMISSIONER FOR PATENTS  
P.O. Box 1450  
Alexandria, Virginia 22313-1450  
www.uspto.gov

| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
| 09/975,466      | 10/09/2001  | Auguste J.L. Sophie  | ASMMC.036AUS        | 8303             |

20995 7590 12/15/2003

KNOBBE MARTENS OLSON & BEAR LLP  
2040 MAIN STREET  
FOURTEENTH FLOOR  
IRVINE, CA 92614

EXAMINER

KIELIN, ERIK J

| ART UNIT | PAPER NUMBER |
|----------|--------------|
|----------|--------------|

2813

DATE MAILED: 12/15/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

09/975,466

Applicant(s)

SOPHIE ET AL.

Examiner

Erik Kielin

Art Unit

2813

AW

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 14 October 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-17, 28 and 30-32 is/are pending in the application.
- 4a) Of the above claim(s) none is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-5, 8-17, 28 and 30-32 is/are rejected.
- 7) ☒ Claim(s) 6 and 7 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

## Priority under 35 U.S.C. §§ 119 and 120

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
\* See the attached detailed Office action for a list of the certified copies not received.
- 13) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.  
a) ☐ The translation of the foreign language provisional application has been received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

## Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 20.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_

### DETAILED ACTION

This action responds to Applicant's Response filed 14 October 2003 (Paper no. 21 and the IDS filed 24 July 2003 (Paper no. 20).

#### *Claim Rejections - 35 USC § 103*

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1, 3-5, 8-17, 28, 30 and 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Patent Application 2002/0027286 A1 (**Sundararajan et al.**) in view of US 6,143,658 (**Donnelly, Jr. et al.**).

Regarding independent claim 1, **Sundararajan** discloses a process for producing an integrated circuit comprising forming a copper damascene structure **140**, **145** on a substrate (Fig. 1A); forming a copper oxide on the copper during CMP (as further limited by instant claim 8); reducing the copper oxide by contacting the oxide with "typically" hydrogen or ammonia plasma --which is a vapor-- (paragraphs [0008] and [0018]), prior to forming a layer comprising silicon carbide, SiC or SiCN (paragraph [0009] and) in the same chamber, wherein the reduction improves the surface for depositing the SiC or SiCN layer, and wherein the layer of SiC or SiCN serves as an etch stop **125** (Fig. 1B; paragraph [0022]).

Regarding independent claim 28, **Sundararajan** discloses a process for producing an integrated circuit comprising the following steps in order,

depositing a copper layer **140, 145** on a substrate (Fig. 1A);  
subjecting the copper layer to a CMP process;  
contacting the substrate with a hydrogen plasma reducing agent (paragraphs [0008]-[0009]); and

depositing a SiN, SiC, or SiCN etch stop layer (paragraph [0009]), as further limited by instant claims 30 and 32.

**Sundararajan** does not teach that the reductive treatment employs contacting the copper oxide with an organic, vapor phase reducing agent that is not plasma activated.

Further regarding claims 1 and 28 and regarding claims 4 and 5, **Donnelly** teaches that vapor phase reduction of copper oxide using an organic reducing agent, specifically H(hfac) or hydrogen hexafluoroacetylacetone --which is the alcohol form or “enol” form of the  $\beta$ -diketone-- after treatment with a hydrogen plasma to provide better conductivity between wiring line and vias by removal of copper oxide (Donnelly, col. 2, line 57 to col. 3, line 28).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use the organic, vapor phase reducing agent of **Donnelly** after the hydrogen plasma reduction of **Sundararajan** because **Donnelly** teaches that the organic, vapor phase reducing agent after hydrogen plasma treatment results in better adhesion of the metal layer than with that resulting from a hydrogen plasma (Donnelly, col. 2, line 57 to col. 3, line 28).

Regarding claim 3, an etch stop layer is a hard mask by definition. Even so, it has been held that to be entitled to weight in method claims, the recited structure limitations therein must affect the method in a manipulative sense, and not amount to the mere claiming of a use of a particular structure. See *Ex parte Pfeiffer*, 1962, C.D. 408 (1961). In this case that the SiC layer

Art Unit: 2813

serves as a stop layer is not manipulative of the method and therefore is not considered to have patentable weight. Moreover, because the materials are the same in the same damascene structure as shown in Applicant's figures, it is very clear that the SiC serves as a hardmask to every extent as indicated by Applicant.

Regarding claims 9, because the copper is necessarily exposed during CMP and cleaning, the oxide is formed by exposure to "a cleanroom atmosphere."

Regarding claims 10-12 and 14-16, **Sundararajan** discloses the deposition necessarily takes place in a first chamber. The temperature therein is 300 to 450 °C. Further regarding claim 16, although the temperature of about 400 °C is not specifically indicated, the selection of the 400 °C is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. See *In re Jones*, 162 USPQ 224 (CCPA 1955)(the selection of optimum ranges within prior art general conditions is obvious) and *In re Boesch*, 205 USPQ 215 (CCPA 1980)(discovery of optimum value of result effective variable in a known process is obvious).

Regarding claim 13, that the second chamber is clustered to a first reaction chamber does not have patentable weight because it is not manipulative of the invention. See *Ex parte Pfeiffer*, as above. Nonetheless, cluster tools are known and it would be obvious to one of ordinary skill in the art to use a cluster tool with separate chambers for the separate processes as in a cluster tool, to protect the copper layer from re-oxidation prior to the deposition of the SiC layer, in accordance with the objective in **Sundararajan**.

Regarding claim 17, **Sundararajan** does not disclose the temperature at which the copper is reduced. It would have been obvious for one of ordinary skill in the art, at the time of

the invention to use the same temperature for reducing the copper oxide layer as that used for deposition in order to save time in changing the temperature, and because it would appear that the reduction temperature being equal to the deposition temperature would work just as well as some other temperature.

3. Claims 2 and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Sundararajan** in view of **Donnelly** as applied to claims 1 and 28 above, and further in view of Applicant's admitted prior art (**APA**).

The prior art of **Sundararajan** in view of **Donnelly**, as explained above, discloses each of the claimed features except for indicating that the silicon carbide layer contains oxygen.

**APA** teaches that it is known to use SiC and SiOC as a barrier/etch stop layer. (See instant specification, p. 3, lines 8-10.)

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use silicon carbide with oxygen, because the selection of a known material suitable for an intended purpose is *prima facie* obvious in the absence of unexpected results. Moreover, one of ordinary skill would be motivated to use SiOC because it has a lower dielectric constant than silicon nitride, thereby aiding in the reduction of RC delay which is highly desired in the art.

#### ***Allowable Subject Matter***

4. Claims 6 and 7 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Art Unit: 2813

5. The following is a statement of reasons for the indication of allowable subject matter:

The prior art does not teach or suggest, in combination with the other claimed limitations, the reduction of a copper oxide layer using the claimed aldehydes or carboxylic acids in non-plasma-activated form before the formation of a silicon carbide layer in the formation of an integrated circuit.

### ***Double Patenting***

6. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and, *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

7. Claims 1, 3-5, 8-17, 28, 30 and 32 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claim 3 of U.S. Patent No.

6,482,740 B2 in view of **Sundararajan**.

Claim 3 of the '740 patent claims each of the claimed features of claims 1, 4, and 5 of the instant application except for the integrated circuit and the silicon carbide.

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use the method of the claim 3 to form an integrated circuit because **Sundararajan** teaches that copper deposition is highly desired to form damascene wiring interconnect. It would have been

Art Unit: 2813

obvious for one of ordinary skill in the art, at the time of the invention to use the silicon carbide layer formed after the copper deposition to beneficially form an etch stop layer for CMP as taught by **Sundararajan**.

### *Conclusion*

8. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

The article **Ueno**, et al. "Cleaning of  $\text{CHF}_3$  plasma-etched  $\text{SiO}_2/\text{SiN}/\text{Cu}$  via structures using a hydrogen plasma, an oxygen plasma, and hexafluoroacetylacetone vapors" Journal of Vacuum Science and Technology, B 16(6), Nov/Dec 1998, pp. 2986-2995 teaches the reduction of copper oxide using organic vapors of hexafluoroacetylacetone for copper damascene processes used for forming integrated circuits.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980. The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached at 703-308-4940. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Erik Kielin  
Primary Examiner  
December 13, 2003